BULL. BOT. SURV. INDIA
Vol.36, Nos. 1-4 : pp. 41-46, 1994

HERBARIUM STUDIES AND THEIR ROLE IN GERMPLASM COLLECTING, CONSERVATION AND USE

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INTRODUCTION

The Indian Sub-continent has been the seat of floristic activities since the early part of nineteenth century (Anon, 1977; 1990). Over 15000 species of higher plants occur in different phytogeographical regions of India and of these about 5,000 species constitute the potentially useful flora (Anon, 1986). Also, the Indian gene centre hold a wealth of 166 species of cultivated plants (Zeven and de Wet, 1982) and 320 species of wild relatives of crop plants and related taxa (Arora and Nayar, 1984). This diversity has been the subject of continuous study by taxonomist, systematic botanists and other interested scientists, and the herbaria have been the focal point in providing a link to such studies. This has been so, because the species wealth that herbaria contain in terms of taxonomic variation is enormous and truly representative of flora of which these have been a part. Herbarium studies are important as they constitute a pre-requisite to understand and assess plant diversity, taxonomically/ botanically, and to establish authentic identity of taxa. Each field number [representing plant specimen(s)] collected by a plant explorer has to be registered/accessioned in the herbarium, as a voucher specimen with requisite entries on the herbarium sheet label with date of collection, source details, ecological notes, uses etc. This paper briefly highlights as to how such herbarium studies could be helpful in plant genetic resources collecting and conservation, and the use of such floristic diversity. Against the activities in herbaria which largely follow classical taxonomic approach, emphasis is laid on collecting of representative genepool variability. It is also stressed that there is at national level. more need to have specific herbaria such as of cultivated plants, and to enrich herbarium collections in crop genetic resources and their wild relatives; and also to document the ethnobotanical information. Further, IBPGR's role in this context is suitably pinpointed.

HERBARIA IN INDIA

The national and regional herbaria operate under the Botanical Survey of India (BSI), Calcutta (Anon, 1990). The Central National Herbarium at Calcutta holds 1.5 million specimens and is the largest in Asia, representing not only Indian plant wealth, but representative collection of South, Southeast Asia and of several other countries, build-up through surveys/ exchange. Among the BSI regional herbaria, prominent ones are the Herbarium of the Northern Circle, Dehra Dun with 100,000 plant specimens, Eastern Circle, Shillong with 250,000 specimens, Southern Circle, Coimbatore with 233,000 specimens, Western Circle, Pune with 150,700 specimens, Central Circle, Allahabad with 48,000 specimens; the Eastern Himalayan Station in Sikkim, the Andaman and Nicobar Islands Station at Port Blair and the Arid Zone Circle at Jodhpur hold between 15,000-20,000 specimens each. Other well represented herbaria are the Blatter Herbarium in Bombay, the Rapinat Herbarium at Tiruchirapalli, the Forest Research Institute (FRI) Herbarium at Dehra Dun and the Herbarium of the National Botanical Research Institute (NBRI) at Lucknow. The Botanical Survey of India is the national organization for all activities on conservation of flora (Anon, 1990). Based on surveys and herbarium records, BSI has listed 660 species in the Red Data Book (Nayar and Sastry, 1987 & 1988). By and large, all herbaria are poorly represented in wild relatives and cultivated-plants diversity.

HERBARIUM STUDIES IN GERMPLASM COLLECTING

A herbarium houses the collections made by different plant collectors from diverse ecological zones/regions and from specific of specialized habitats. It is an expression on field work carried out in the past and presently available for further study and scrutiny on taxonomy of species, their ecology and distribution. The plant explorer invariably uses this 'invaluable treasure' of plant specimens from diverse habitats to synthesize information to plan and maximize his search to tap genetic diversity. The noteworthy points of explorer's concern are :

1. Herbarium studies offer a quick approach to get familiar with the flora or plants of the target area. It is convenient under one roof to examine well classified wealth of specific species/ genera etc. and to grasp taxonomic differences between species and the within species variation.

2. From the source information on herbarium sheet labels, it is possible to chart/map distribution of species represented in different regions and habitats. This study provides important clues for future plant explorations (Arora, 1981) :

a) Diverse ecological information on habitat variability in areas from where collecting has been earlier carried out. Thus, further germplasm collecting can be planned more meaningfully, within the range of ecological amplitude of the species. It is also helpful in locating ecotypic variation.

b) Charting / mapping of distribution of species helps in assessing gaps in their collecting, thereby prioritizing areas for future collecting. It is also helpful in focussing on collecting of endemic, rare and endangered taxa.

c) Information on herbarium labels, provides range of flowering/ fruiting period and also this can be related to habitat and ecology of species, thereby planning suitable itinerary; this is helpful in fact in overall planning and logistics.

Such strategies based on herbarium studies have been effectively used in collecting and understanding distribution of diversity in *Vigna* species (Anon, 1985); and in other explorations such as of sesame, okra, cucurbits, *Solanum, Oryza, Saccharum* and related taxa, carried out by the National Bureau of Plant Genetic Resources, New Delhi.

USE OF HERBARIUM STUDIES

1. Recording ethnobotanical information :

Herbarium-label records on the surveys carried out by plant explorers particularly in remote pockets of natural or cultivated plant diversity and in areas where ethnic communities dominate, point out to new uses of plants. Diverse uses of same species by different communities have been recorded (Jain, 1990). This is particularly so in case of species used locally in medicine, as spices or condiments; and to lesser extent as edible types. Under the All India Co-ordinated Research Project on Ethnobotany (AICRPE), under the Department of Environment and undertaken by Botanical Survey of India, Calcutta (Anon, 1984), surveys were conducted in the eighties and ethnobotanical information on folklores, plants used by tribals for food, fodder, shelter, fibre, dyes, medicine etc., was documented for about 1000 species. Rai Chaudhari *et al.* (1979) conducted screening of herbarium records at Central National Herbarium (CNH) and the Herbarium of the Indian Museum (ISIM), Calcutta. Uses on 60 species could be recorded. Interesting information have also been compiled on *Solanum* and *Polygala* species (Jain, 1990), and on ethnobotany of local cultivars of *Oryza* from southern parts of Western Ghats, India (Manilal, 1990). Even cryptic notes on uses are also relevant as they form a base for future enquiries.

2. Monographic approach :

The role of herbaria and museums in the preparation of economic plants monographs need not be overemphasized (Kashyapa, 1977). Herbarium helps to provide a wide range of plant specimens for taxonomic revision. Information is generated on closely and distantly related groups and species diversity assessed at different taxonomic levels. New light is thrown through taxonomic studies on inter-relationship of taxa i.e. *Cajanus* and *Atylosia* (van der Maesen, 1986). Since a very large collection assembled from several world herbaria is studied, the data on distributional and habitat range helps understand species concentration in particular locations/ geographical areas.

3. Conservation approach :

Such information as above is also useful in locating sites for *in situ* conservation of plants in their native habitats. Further, *ex situ* conservation measures can be adopted and species can be raised in arboreta, field/botanic gardens, national parks etc.

4. Herbarium specimens as research material :

Interesting cases have been recorded of the use of herbarium specimens for investigating chromosome number. The pressed material has been used and chromosomes counts made from pollen of a herbarium specimen in the Himalayan species of *Impatiens; I. roylei; I. edgeworthi, I. brachycentra,* and *I. sulcata;* in *I. roylei;* from a 50 years old collection (Khoshoo, 1956).

As an adjunct to reading herbarium labels, one can make spot tests for particular chemicals on minute bits of plant materials carefully selected to preserve the specimen's integrity. This in large herbaria, helps to determine the approximate occurrence of a chemical in particular groups of plants. Stable alkaloids can yield a positive test after 125 years in herbarium (Raffauf and Altschul, 1968; Altschul 1977).

5. Adaptation traits :

The general data on location, ecological notes etc. on herbarium labels, is helpful in providing information on the possible physiological or stress situations under which several taxa grow (Water logged, salinity tolerant wild *Oryza* spp; extremely cold adaptable desert habitat of *Cicer microphyllum;* sandy hot arid desert habitat of fodder grasses *Cenchrus* and *Lasinurus* spp.). In case of perennial species such as highly cold adaptable *Rosaceous* fruit trees, such approach could help locate hardy root stocks. Also material collected from specific agro-ecological locations such as shifting cultivation sites would be drought hardy (Anon, 1990). These traits are useful in crop improvement.

6. Information dissemination :

The herbarium provides a meeting place for scientists from within the national programme and abroad, to share views and develop contacts and strengthen research base for future taxonomic studies. It is a centre for research and education and has focus on dissemination and exchange of information and material dealing with all aspects of floristic / taxonomic research. With use of computer facilities, such data base needs to be established or strengthened (Subramanyam and Sreemadhavan, 1970).

FUTURE EMPHASIS

Considering the foregoing apprisal on herbarium studies and their role in germplasm collecting, conservation of diversity and its use emphasis needs to be placed on the following:

1. Apart from traditional classical approach, study of genepool diversity, variation in species / within species populations, particularly in cultivated plant taxa (Harlan and de Wet 1971; Parker, 1983) and the concept of mass herbaria/inclusive herbaria (Anderson, 1941), provide larger scope to study/examine a wide array of herbarium speci-

mens. IBPGR has initiated systematic and ecogeographic studies on crop genepools such as on herbarium surveys of African *Corchorus* species (Edmonds, 1990). This approach by the IBPGR and IJO (International Jute Organization) has helped compile comprehensive background information on the occurrence and distribution of the genetic diversity of a cultivated crop plant in a center of diversity. It also helped in turn to collect germplasm from the existing genepools. Such a strategy needs to be widely adopted in collecting genetic resources/ genepools of other crops. Also, areographic techniques for targeting and conserving species diversity as carried out in *Phaseolus* (Nabhan, 1990), need to be widely studied. Further, IBPGR has given due consideration to taxonomic/morphological characters in preparing crop descriptors, and this information needs to be suitably integrated into taxonomic revisions particularly on taxa of cultivated plants and their wild relatives.

2. Taxonomic revision of genera of cultivated plants in India needs to be given priority by the Botanical Survey of India. It is a specialized task and needs coordinated efforts by both BSI, NBPGR, NBRI; to identify priorities. Such coordination is also required in sharing of germplasm, depositing herbarium specimens etc., of new species described in crop plant taxa such as of *Oryza inandamanica* by BSI and *Curcuma karnatakensis, C. malabarica* and *C. kudagensis* by NBPGR.

3. Considering the gaps in collecting and information thereof, it is desired that Botanical Survey of India, NBPGR and other organizations concerned with conservation of plant wealth may prioritize collecting of rare and endangered taxa and the wild relatives of crop plants from areas of occurrence/diversity of such flora.

4. Systematic efforts to undertake documentation of useful notes from herbarium specimens and investigate these uses further, has not been carried out. A special project is needed to run for several years to record such data. Schultes (1960) and Altschul (1975, 1977) have made significant studies in this field and extracted useful information from herbaria (Gray Herbarium, Harvard Univ.; and Arnold Arboretum); yielding notes on 7000 species belonging to 900 genera and 145 families, providing several additional and new uses.

5. Also, ethnobotany of specific taxa may yield fruitful information. Recent studies on *Clitoria* (Fantz, 1991) based on herbarium collections provide several additional uses of *C. ternacea* and other species.

6. Under the All India Research Project of Ethnobotany, already discussed earlier, a good beginning was made by NBRI, Lucknow to develop museum and herbarium on ethnobotanical findings. Such specific emphasis needs due priority for documenting native knowledge.

7. With more of biosystematic approach (Heywood, 1968), there is need to have available diversity represented in fields/gardens/ arboreta; particularly for raising perennial plants, vegetatively propagated materials, experimental/ cytological materials, other taxonomically disputed taxa; and have their authentic specimens kept in the herbarium.

8. At national level, there is need for networking on database for herbaria, with the Botanical Survey of India, as the nodal organization.

9. In national perspective, apart from the existing herbaria, there is need for specific herbaria of cultivated plants. Two such herbaria have come up recently, namely, the Herbarium of crop plants at NBPGR, New Delhi which is already functioning and stores specimens of cultivated plants, wild relatives, weed types etc. Priority needs to be given to collect wild relatives for which NBPGR has synthesized information on their occurrence, distribution etc. (Arora and Nayar, 1984). The second is the MSSRF Herbarium, at Madras. The latter is a new facility created under the Genebank and Herbarium of the M.S. Swaminathan Research Foundation at its

Centre for Sustainable Agricultural and Rural Development. This herbarium will lay emphasis to hold specimens of landraces of cultivated plants, rare and endangered species and other such potential diversity including wild relatives; largely from the Eastern and Western Ghats. IBPGR will be associated with the development of this herbarium and the genebank facility.

To conclude, research base for taxonomic studies in terms of more interdisciplinary approach would demand better facilities. The Botanical Survey of India since 1950's has done a commendable service, but coordinated efforts at the national level need to be streamlined to evaluate priorities to gear up work on the 'Flora of India Project' on one hand and to simultaneously create a School or Centre for cultivated plant taxonomy (which is more intricate but needs better deal), particularly when India happens to be a centre of diversity for crop plants. With the existing infrastructure of network of herbaria and field stations with the Botanical Survey of India and other concerned organizations, such as NBPGR and NBRI, such achievements look both feasible and promising with the national programme.

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